HELIX PC BUBBLE DISK

USER'S MANUAL

VERSION 1.2
May 1984

HELIX LABORATORIES, INC.
16776 Bernardo Center Dr. Ste.106A
San Diego, California 92128
(619)451-0270

FIRST EDITION : May 1984

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INTRODUCTION

The PC Bubble Disk is a bubble memory adapter board for the IBM Personal Computer and compatibles. The board holds four Intel one-megabit magnetic bubble memories, providing 512 Kbytes of non-volatile, solid-state memory.

Like a floppy or hard disk, a bubble memory stores data as magnetic domains that do not require power to be retained. Unlike the above devices, the bubble memory does not have any mechanical moving parts and thus exhibits 20-year mean-time-before-failure reliability even when continuously operated. Bubble memory data is not individually byte-addressable and does not occupy memory address space. Instead, commands and data are sent through an I/O port to the Intel single-chip bubble memory controller (BMC), which is similar to a disk controller, for random I/O operations on blocks of data.

An EPROM on the bubble board contains firmware that makes the Bubble Disk emulate a fixed disk at the BIOS command level. Operating systems that support the fixed disk, including PC-DOS 2.0, Softech Pascal IV.13 and CP/M-86 for th PC/XT, will work with the Bubble Disk without software patches. Fixed disk software features, such as the RESTORE and BACKUP commands and partitioning to hold multiple operating sytems, are thus available to the Bubble Disk user. Functionally, a single Bubble Disk board appears to an operating system as a 4 head, 15 cylinder fixed disk with 17 sectors per track.

The on-board EPROM occupies 8 Kbytes of address space (even if a 4 Kbyte 2732 EPROM is installed). The starting address of the EPROM is jumper-selectable for compatibility with other adapter cards, such as the fixed disk adapter. The Bubble Disk works on the IBM PC/XT with a single fixed disk installed and is jumper-selectable to appear before or after the fixed disk drive.

The I/O port address for the board is also jumper-selectable, allowing multiple-board operation of up to four boards, depending on power supply capabilities. Additional boards increase the size of the Bubble Disk drive instead of appearing as separate drives, making a single Bubble disk drive with up to a 2 megabytes of capacity possible.

The Intel bubble support chips provide built-in 14 bit error checking and correction (ECC) code and power-fail protection circuitry. The four bubble memories are operated in parallel for a transfer rate (400 Kbits/sec) four times the single bubble rate. Data transfers are made using the system board's direct memory access (DMA) with an interrupt (INT) to signal operation completion. These signal lines are tri-stated when not in actual use. The board's DMA and INT channels are jumper-selectable but DMA channel 3 and INT channel 5 must be chosen for proper operation with the Bubble BIOS firmware.

For full Bubble Disk capabilities, it is important that the target PC have the newer BIOS ROM with the ROM_SCAN routine that scans for EPROM's on add-on boards. The newer IBM PCs with the 256 Kbyte system board, the newer COMPAQs (since December 83), and all the IBM XTs have this new version, but the older PCs with the 64K system board normally do not. The Bubble Disk will operate with the older BIOS but will not boot the operating system. Instead, after booting from floppy disk, a small program must be run to install the bubble board as a drive. This bubble install program may be placed in an AUTOEXEC batch file for convenience.

The board features a write-protect switch on the board bracket, accessible from outside the system unit cabinet. This switch is similar to the notch on a floppy disk and will prevent any files on the Bubble Disk from being erased or overwritten. There is a jumper select option to change the function of this switch to an on-line/off-line switch for convenient operation with a fixed disk or other IPL device.

FIRST-TIME INSTALLATION

INSTALLATION OVERVIEW

Installation of the Bubble Disk is simplest for users with the ROM SCAN routine in the BIOS ROM of their PC. After setting jumpers, the board is inserted into an expansion slot on the system board. Partitioning and formatting are done with the same programs normally used for the fixed disk. No patching of the operating system is required except in the special case of using the Bubble Disk with a fixed disk under CP/M-86.

Without the ROM SCAN feature, bubble board installation requires the creation of a small initialization program in the case of PC DOS or a system patch in the case of CP/M-86. In this situation, the floppy disk of drive A must be used to cold boot the operating system, since the bubble driver is hooked into the system after the bootstrap process.

HANDLING PRECAUTIONS

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PRECAUTIONS IN HANDLING THE BUBBLE DISK BOARD

THE BUBBLE DISK BOARD HAS STATIC SENSITIVE COMPONENTS AND SHOULD BE KEPT IN ITS ANTISTATIC WRAPPING OR ON A SIMILAR PROTECTIVE SURFACE UNTIL INSTALLATION. PLEASE HANDLE THE BOARD ONLY BY THE EDGES AND AVOID TOUCHING THE GOLD EDGE CONNECTOR OR PRESSING ON THE METAL CAN OF THE CLOCK CRYSTAL.

SERIOUS DAMAGE CAN RESULT TO THE BUBBLE DISK BOARD IF IT IS INSERTED OR REMOVED FROM A PC'S EXPANSION SLOT WHILE THE SYSTEM POWER IS ON. IT IS RECOMMENDED THAT THE POWER CORD TO THE PC BE UNPLUGGED BEFORE ATTEMPTING BUBBLE DISK BOARD INSERTION OR REMOVAL.

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JUMPER FAMILIARIZATION

The small, blue jumpers on the component side of the bubble board in the area just above the gold-fingered edge connector are used to configure the Bubble Disk for various modes of operation. Figure 1 is a schematic

view of these jumpers as seen with the edge connector pointing downward. The figure shows the jumper groups in their approximate relative positions to each other with the "J" number designator for each group placed the same as it is on the board. The function of each group is indicated in the figure, but not on the board.

The jumper settings in Figure 1 are the normal positions of the jumpers when the bubble board is first unpackaged. At this time, in order to establish a common starting point, the user should ensure that the bubble board jumpers conform to the settings in this figure. Note in particular that the J2 and J6 jumpers are to be positioned vertically and not horizontally.

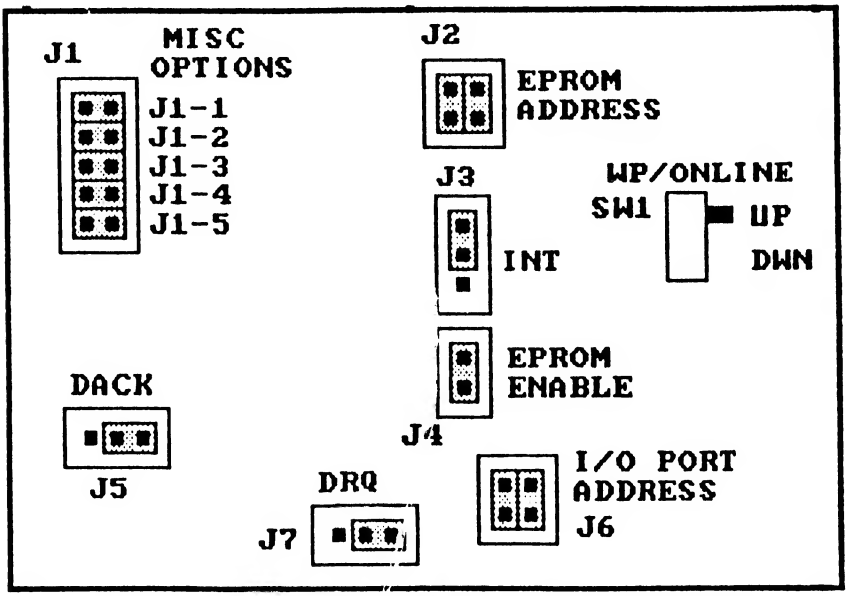


FIGURE 1 : INITIAL JUMPER SETTINGS OF THE BUBBLE DISK BOARD.

JUMPER SETTINGS FOR FIRST-TIME INSTALLATION

With the bubble board jumpers initiallized to the setting of Figure 1, the user is ready to configure the board for installation. First, remove the right jumper of the J2 jumper group. This group's jumper setting should now be the same as in Figure 2.

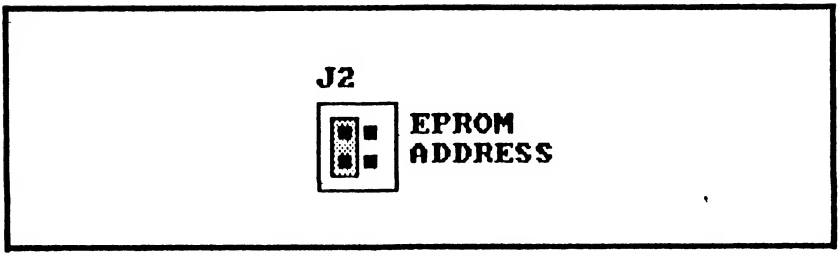


FIGURE 2 : JUMPER SETTING OF J2 GROUP FOR EPROM ADDRESS = CA000.

The J2 setting of Figure 2 places the starting address of the board's Bubble BIOS EPROM at hex CA000. This address is in the memory space (hex C8000 to hex F4000) reserved for ROMs contained on add-on boards, such as the fixed disk adaptor board whose ROM starts at hex C8000. If it is known that the hex CA000 address will conflict with the EPROM of another add-on board currently on the system, skip to the section JUMPER OPTION SUMMARY and choose a setting for a higher address. Note that there are some multifuntion cards that provide an option to use these high memory locations for a RAM disk. Obviously, this high memory option cannot be used with the fixed disk or the Bubble Disk.

If there is no fixed disk on the system, the user may now skip to the next section on board insertion.

If the system has a non-IBM fixed disk adapter board without a driver ROM at address hex C8000, but instead is hooked into the operating system after the bootstrap with an installable device driver, then the user should skip to the next section on board insertion.

For systems with an IBM fixed disk adapter board, or look-alike, that has its driver ROM at address C8000, it is necessary to remove the lowest jumper on group J1, i.e., J1-5. This informs the Bubble BIOS that a fixed disk is present. In addition, the second jumper from the top of group J1, J1-2, is to remaint inserted or be removed, depending on whether the user wants the bubble drive to appear before or after the fixed disk drive respectively. The final jumper settings of these configurations are shown in Figures 3 and 4 on the next page.

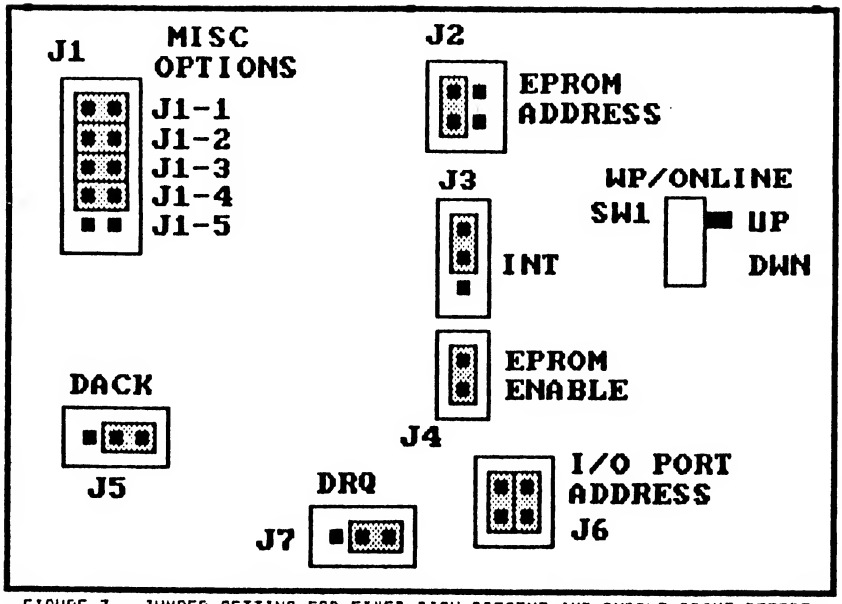


FIGURE 3 : JUMPER SETTING FOR FIXED DISK PRESENT AND BUBBLE DRIVE BEFORE THE FIXED DISK DRIVE.

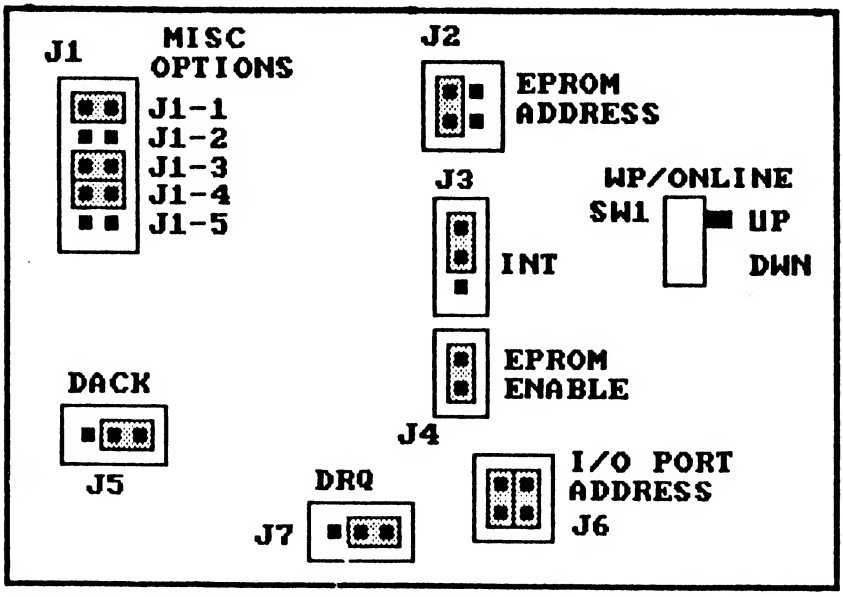


FIGURE 4 : JUMPER SETTINGS FOR FIXED DISK PRESENT AND BUBBLE DRIVE AFTER THE FIXED DISK DRIVE.

INSERTING THE BOARD

The Bubble Disk board will fit and seat properly in any of the full length expansion slots. The black plastic card guide provided with the bubble board should be pressed into the holes at the end of the chosen slot position if one is not already present.

Check that the power to the IBM PC is OFF before inserting (or removing) the Bubble Disk board. A good precaution is to disconnect the power cord from the chassis before the bubble board is handled.

It is also critical to ensure that the board's gold edge connector is FULLY INSERTED into the slot. When seated properly, the top of the board's rear bracket will be flat against the retaining ledge, flush with the other board brackets. The front edge of the board should be held by the plastic card guide. Screw the bracket down securely before applying power.

NOTE : Users of portables should ensure that all available board securing options are utilized. For instance, Compaq users need to ensure that the appropriate black plastic piece on the lid of the expansion cabinet is oriented properly to hold down the top of the bubble board. In some cases this will involve removing and reinserting the piece in the opposite orientation.

POWERING UP FOR THE FIRST TIME

As first received, the Bubble Disk is completely cleared with zeros in all storage locations. It is necessary to first create a DOS partition with the PC-DOS 2.0 program, FDISK, and then format it with the program, FORMAT.

With the PC-DOS 2.0 diskette in drive A, turn on the power to the system. The system should boot from floppy diskette in the normal fashion. If a "1702" appears on the screen, there was a problem in initializing the Bubble Disk. The power should be shut off and the jumper settings rechecked.

Once DOS has been booted and the prompt is displayed, run the program, FDISK. If FDISK indicates that no fixed disk is present, it is possible that your system does not have the newer BIOS ROM with the ROM SCAN routine, and therefore it is necessary to run a small installation program as described in Appendix A before proceeding.

Once the FDISK option menu is displayed, follow the instructions in the PC DOS 2.0 manual to create a DOS partition on the bubble disk that uses the entire "fixed disk."

If a fixed disk is also on the system, multiple fixed disk drives will be indicated by the presence of the FDISK option "5. Select Next Fixed Disk Drive." Use this command and the "4. Display Partition Data" option to find the bubble drive before creating the DOS partition. The bubble drive is distinguished by a total disk space of 15 cylinders.

Once the bubble disk drive is located, choose the option "1. Create a DOS Partition" and create a DOS partition that uses the entire bubble disk. The last step in this option will reboot DOS.

After creating a DOS partition with FDISK and rebooting, it is still necessary to format the Bubble Disk with the DOS 2.0 FORMAT program. At this point it is important to determine the drive letter of the bubble disk, since formatting the wrong disk and thus wiping out the files on that disk would be disasterous.

The drive letter for the Bubble Disk will depend on the positions of switches 7 and 8 on SW1 of the IBM PC system board and whether a fixed disk is present. The switches indicate how many floppy drives are installed. If two or less drives are indicated, (7=on,8=on or 7=off,8=on) the first "fixed disk" drive will be drive C. If four floppy drives are indicated (7=off,8=off), then the first "fixed disk" drive will be drive E (even if less than four floppy drives are installed).

If there is no fixed disk on the system, then the Bubble Disk will be the first "fixed disk" drive at C or E. If a fixed disk is present, then the Bubble Disk drive could be the first (drive C or E) or second (drive D or F) "fixed disk" drive depending on the setting of the second jumper on J1 as discussed in the previous section.

In either case, before formatting the Bubble Disk, use the program, CHKDSK, to confirm the drive letter of the fixed disk if present on the system and be sure not to use that letter when formatting the bubble drive. During the format process, it is recommended that the Bubble Disk be given a volume name that will distinguish it from the fixed disk. For

instance, if the bubble drive is C, then the command :

```
A>FORMAT C:/S/V
```

will install the operating system and ask for a volume name. If a volume name like "BUBBLE DISK" is used, this will be displayed during the DIR or CHKDSK listing making immediately clear the drive being accessed.

BUBBLE DISK OPERATION

Once partitioned and formatted, the Bubble Disk will respond just as a fixed disk does to all disk operating system commands and program accesses. That is, in addition to the normal disk commands, it will respond to special fixed disk commands, such as RESTORE and BACKUP. As is the case with the fixed disk, the diskette-only commands, such as DISKCOPY or DISKCOMP, will return an error when attempted on the Bubble Disk.

BOOTING FROM THE BUBBLE DISK

If there is an active partition on the Bubble Disk and the operating system for that partition is present, then the Bubble Disk will bootstrap that operating system from power-off or ALT-CNTL-DEL reset, provided there is no disk in drive A or drive A's door is open. If a bootable fixed disk is also present, the boot is attempted only from the first "fixed disk" drive as determined by the jumper J1-2 on the bubble board as discussed above.

OTHER OPERATING SYSTEMS

Operating systems other than PC-DOS 2.0 that support the hard disk will have software similar to FDISK with which to create a hard disk partition for use by that operating system. The Bubble Disk should be considered a fixed disk when following the instructions for these programs. In some cases, the operating system will assume that the Bubble Disk has a full 306 cylinders of capacity and indicate this during the partitioning setup operation. This discrepancy should be ignored and partitioning limited to the Bubble Disk capacity of 15 cylinders per installed board.

Just as with PC-DOS, in order to boot these operating systems from the Bubble Disk, the operating system files must be installed and the partition for the desired operating system made the active partition.

PARTITIONING CP/M-86

The partition for Version 1.1 of CP/M-86 for the PC XT must start at cylinder 0 and be at least 10 cylinders long. Partitioning is done with the program, HDMAINT. Note that even though the Bubble Disk drive is referred to as "Disk B" during the HDMAINT program, the bubble drive will appear as drive C in the operating system environment.

As described in the CP/M supplement for the Hard Disk, the contents of the system disk in drive A, including the CCPM.SYS file needed for booting, can be copied to the Bubble Disk with the PIP command:

```
#c:=a:*.*[rv]
```

Note that the CP/M partition on the Bubble Disk must be deliberately made active using the HDMAINT program if booting from the bubble is desired.

PARTITIONING SOFTECH PASCAL

The partition for Softech Pascal Version IV.13 is created using the file, DISKUTIL.1 . Note that after creating the partition, the system must be rebooted before the Bubble Disk will be recognized as an on-line volume. For the Bubble Disk to boot this operating system, the file, SMSFDBOOT.7C00, provided on the Pascal system disk must be transferred

to the Bubble Disk volume using the Filer Transfer command :

Transfer? SMSFDBOOT.7C00, BUB:

assuming the bootable system disk is the prefix volume and the bubble drive has the volume name,"BUB:". Of course the usual system files necessary for booting must be transferred as well, and the Pascal partition must be made active using the DISKUTIL.1 program.

MULTIPLE PARTITION OPERATION AND FDISK

The PC-DOS 2.0 program, FDISK, displays a few idiosyncracies when multiple operating systems are present and a change in the active partition is attempted. These problems are not related to the Bubble Disk, and they appear to have been corrected with DOS 2.1 .

For instance, when two partitions are present and the first is active, an attempt to make the second partition the active partition will appear to create a third partition, at least on the display. When this happens, accept the situation and return to the main menu. Now run the "Change Active Partition" routine once more and select partition 3. This will cause the display to again indicate only two partitions with the second partition active as desired.

Another trouble mode appears when a partition is choosen to be active, but the previously active partition is not returned to normal status. As in the case above, repeat the "Change Active Partition" routine and again select the desired partition which should correct the problem.

JUMPER OPTION SUMMARY

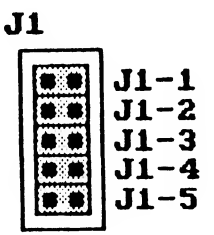
This section summarizes the various jumper settings on the bubble board, some of which have already been introduced and discussed in the previous sections.

In the following notation, a "JP" designates that a jumper should be inserted at the location specified, and an "NJP" signifies that the jumper should be absent or removed. Orientations, such as top, bottom, right, and left, assume the board is viewed from the component side with the gold edge connector pointing downward.

The jumpers are functionally grouped and identified on the bubble board with the designations J1 to J7 near the jumper positions. The following is a summary of the function of these jumper groups.

GROUP J1 : MISC OPTIONS (BOARD 1 ONLY)

POS	JUMPER#	JP	NJP
TOP	J1-1	SINGLE BOARD	MULTI-BOARD
	J1-2	BEFORE FIXED DISK	AFTER FIXED DISK
	J1-3	WP SELECT	ONLINE/OFFLINE
	J1-4	NORMAL	RESERVED
BOT	J1-5	NO FIXED DISK	FIXED DISK ATTACHED

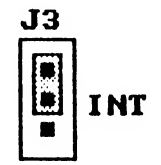


GROUP J2 : EPROM ADDRESS SELECT

LEFT	RIGHT	ADDRESS (HEX)
JP	JP	C8000
JP	NJP	CA000
NJP	JP	CC000
NJP	NJP	CE000

GROUP J3 : INTERRUPT SELECT

JUMPER POSITION		CHANNEL SELECTED
JP	TOP	INTERRUPT 5 *
JP	BOTTOM	INTERRUPT 6
NJP		NO INTERRUPT



GROUP J4 : EPROM ENABLE

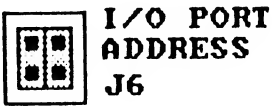
JUMPER	SELECT
JP	EPROM ENABLED
NJP	EPROM DISABLED

GROUP J5 : DACK SELECT

JUMPER POSITION		CHANNEL SELECTED
JP	LEFT	DACK 2
JP	RIGHT	DACK 3 *
NJP		NO DACK

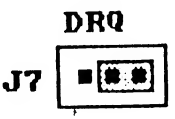
GROUP J6 : I/O PORT SELECT

LEFT	RIGHT	I/O PORT ADDRESS (HEX)
JP	JP	3C0-3C3
JP	NJP	3C4-3C7
NJP	JP	3C8-3CB
NJP	NJP	3CC-3CF



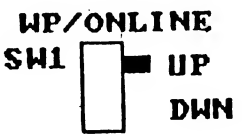
GROUP J7 : DRQ SELECT

JUMPER POSITION		CHANNEL SELECTED
JP	LEFT	DRQ 2
JP	RIGHT	DRQ 3 *
NJP		NO DRQ



SW1 : WRITE PROTECT/ONLINE

SWITCH	SELECTION
UP	WRITE-ENABLED/ONLINE
DOWN	WRITE-PROTECTED/OFFLINE



* These settings for INTERRUPT, DRQ, and DACK must be used for the Bubble BIOS EPROM driver software to function properly.

HARD DISK OPTION

The Bubble Disk will work in the IBM PC/XT with a fixed disk adapter card and a single fixed disk installed. If multiple bubble boards are installed on the system as described in the next section, the following jumper instructions only apply to board 1.

1) Since the ROM on the fixed disk adapter card is at address hex C8000, the Bubble Disk EPROM must be set to a higher address using jumper J2 settings from the table below. It does not matter which higher address is chosen as long as the address does not conflict with the ROM space of any other intelligent adapter boards that might be installed on the system.

BUBBLE BOARD 1 : J2

JUMPER POSITION LEFT	JUMPER POSITION RIGHT	EPROM ADDRESS (HEX)
JP	JP	C8000
JP	NJP	CA000
NJP	JP	CC000
NJP	NJP	CE000

2) After jumpering an address higher than hex C8000 for the EPROM, the lowest jumper on J1 (J1-5) should be removed. This notifies the Bubble BIOS that a fixed disk is present. The system will "hang" if this jumper is not removed and a fixed disk adapter card is present on the system.

3) The Bubble Disk will be installed by the operating system with a drive letter before or after the fixed disk drive letter, depending on the setting of the second J1 jumper (J1-2) :

BUBBLE BOARD 1

J1-2 SETTING	C:(E:)	D:(F:)
JP	BUBBLE DISK DRIVE	FIXED DISK DRIVE
NJP	FIXED DISK DRIVE	BUBBLE DISK DRIVE

If floppy drive A is empty or its door is open during power-on or reset, the system will attempt to boot the operating system from the the first "hard disk" drive as configured above.

MULTI-BOARD SINGLE DRIVE OPTION

Depending on the power supply capability, up to four boards can be installed in the system at one time. Each board adds an additional 15 cylinders (512 Kbytes) of storage to the Bubble Disk drive. For this configuration the following jumper settings are necessary:

1) The Bubble BIOS EPROM should only be enabled on one board. Choose a board as bubble board 1 and disable the EPROM on all the other additional boards by removing their jumper on J4.

2) Each board must have its own I/O port address space. These addresses must be consecutive, starting with address hex 3C0 on bubble board 1. Set the I/O port address space on each board with J6 as follows:

	JUMPER POSITION			
J6	LEFT	RIGHT	I/O PORT	BUBBLE BOARD
	JP	JP	3C0-3C3	1
	JP	NJP	3C4-3C7	2
	NJP	JP	3C8-3CB	3
	NJP	NJP	3CC-3CF	4

3) On bubble board 1 only, the first jumper (J1-1) from the top of J1 should be removed. This enables the multiboard option.

4) Finally, the TOTAL number of bubble boards should be indicated on J1 of bubble board 2 only, using the first (J1-1) and second (J1-2) jumper positions from the top of J1 as follows:

BUBBLE BOARD 2 ONLY		
J1-1	J1-2	TOTAL NUMBER OF BUBBLE BOARDS
NJP	JP	2
JP	NJP	3
NJP	NJP	4

The remaining J1 jumpers of bubble board 2 (J1-3 to J1-5), and the J1 jumpers of all higher number bubble boards are ignored. Only the J1 jumpers and bracket switch of bubble board 1 control the options described in the JUMPER OPTION SUMMARY section.

5)After changing the number of bubble boards on a system, it is necessary to run FDISK and FORMAT to reconfigure the partition and the directory sectors to reflect the change in Bubble Disk capacity. These programs will wipe out files previously stored on the bubble boards, so the Bubble Disk should be backed-up before adding or subtracting bubble boards from the system.

The Figures 5 and 6 that follow show an example of the mulitiboard jumper settings for a two board configuration.

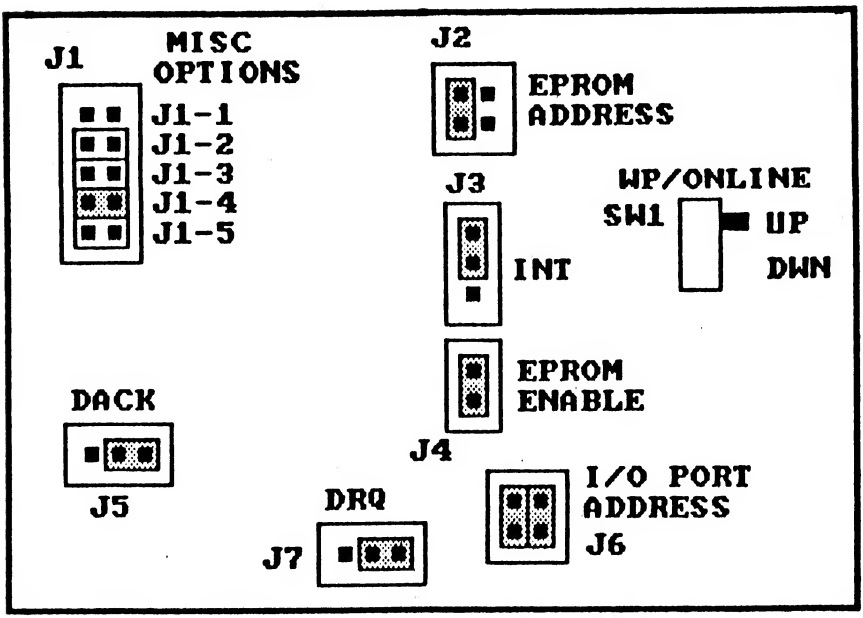


FIGURE 5 : BOARD 1 WITH THE MULTIBOARD OPTION CHOSEN. NOTE THAT THE FIXED DISK OPTION MAY BE CHOSEN AS WELL.

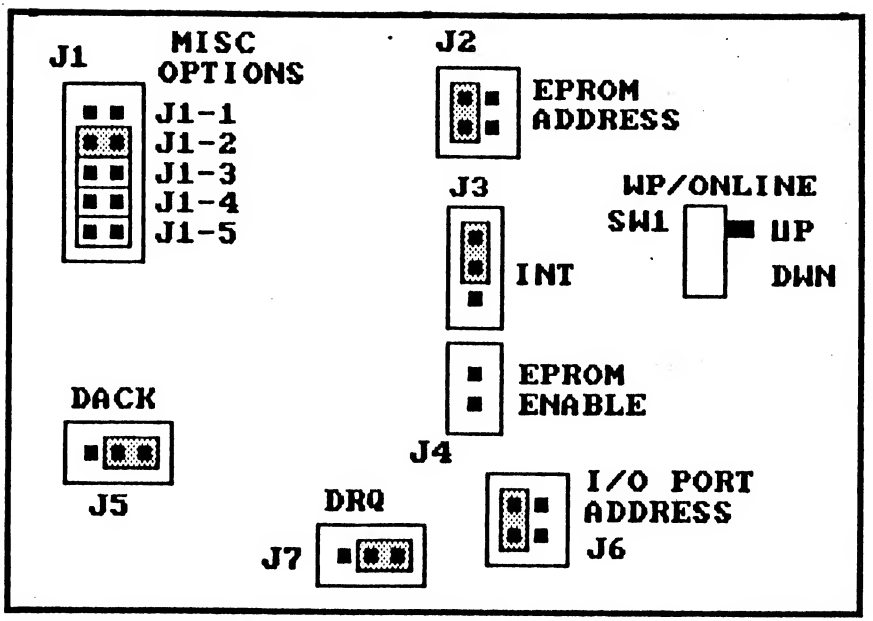


FIGURE 6 : BOARD 2 WITH MULTIBOARD OPTION CHOSEN AND TWO BUBBLE BOARDS INSTALLED ON THE SYSTEM.

WRITE-PROTECT/ONLINE OPTION

The function of the slide switch (SW1) on the bracket of the bubble board depends on the setting of jumper J1-3. If this position is jumpered, then the slide switch acts as a write-protect switch. In the "up" position writing to the disk is enabled. In the "down" position an attempt to write to the disk returns a "write-protect error" message.

With the J1-3 jumper removed, the bracket switch acts as an online/offline switch. When the system is booted with the switch in the "up" position, the Bubble Disk operates normally and is installed as a drive. When the system is booted with this switch in the "down" position, the board is essentially offline and is not recognized as a drive by the system. If an IBM fixed disk is also on the PC and the Bubble Disk is configured as drive C and the fixed disk as drive D, then with the Bubble Disk offline, the fixed disk will be drive C with booting capability when when floppy is not present in drive A.

CP/M-86 WITH BUBBLE AND FIXED DISK

When the Bubble Disk is used alone with CP/M-86 FOR THE PC/XT, it will operate as a fixed disk with no patching to the operating system necessary. However, when the Bubble Disk and a fixed disk are installed together, a small patch must be applied to the CP/M operating system. This patch prevents CP/M from writing over the INT 42H location during CP/M initialization. This is where the fixed disk vector is relocated by the PC Bubble BIOS.

The following is the procedure for patching CP/M-86 for the IBM PC/XT with version number 1.1 :

1) As a precaution, copy the CP/M system disk to another floppy disk and use the copy for the following patch.

2) Boot the CP/M system from the disk and determine if it is a single-sided or two-sided disk by using the command, STAT DSK:. The single-sided disk will show a 156 Kilobyte Drive Capacity and the two-sided disk will indicate a 316 Kilobyte Drive Capacity.

3) Insert the PC DOS disk in drive A and the CP/M disk in drive B. Boot the PC DOS operating system and run the program, DEBUG.

4) If the CP/M disk is a single-sided diskette, enter:

   -L 3B80 1 6C 1

   else if the disk is two-sided enter:

   -L 3B80 1 6E 1

   This command will read a sector (6C or 6E) from drive B into memory at offset EB80 from the current CS segment.

5) Enter the following disassemble command and check that the listing is the same as shown below. If not try repeating from step 4. If it is still different, then the CP/M version is not the same and cannot be patched with this procedure.

```
-U 3D30 <cr>
XXXX:3D30 93              XCHG    BX,AX
XXXX:3D31 E2FC            LOOP    3D2F
```

```
XXXX:3D33 83C708          ADD     DI,+08
XXXX:3D36 B97C01          MOV     CX,017C
XXXX:3D39 AB              STOSW
XXXX:3D3A 93              XCHG    BX,AX
XXXX:3D3B E2FC            LOOP    3D39
XXXX:3D3D C7068003060B     MOV     WORD PTR [0380],0B06
XXXX:3D43 8C0E8203        MOV     [0382],CS
XXXX:3D47 C7067800C63A     MOV     WORD PTR [0078],3AC6
XXXX:3D4D 8C0E7A00        MOV     [007A],CS
-
```

6) Using the assemble command shown below, change the program lines as indicated:

```
-A 3D33 <cr>
XXXX:3D33 ADD DI,0C <cr>
XXXX:3D36 MOV CX,178 <cr>
XXXX:3D39 <cr>
-
```

7) These changes can be checked by repeating step 5.

8) Write this changed sector data back to the disk using the appropriate command:

```
-W 3B80 1 6C 1 <cr>        (for single-sided disk)

-W 3B80 1 6E 1 <cr>        (for two-sided disk)
```

9) The CP/M system disk is now patched and can be run normally.

INTERFACE DESCRIPTION

The interface for a single PC Bubble Disk card uses four consecutive I/O port addresses starting at hex 3C0. In multi-board operation, each additional board must be jumpered to use the next four I/O port addresses adjacent to the previously installed board. A maximum of four boards may be installed which would use I/O port addresses hex 3C0 to 3CF.

The first two I/O port addresses of each board provide direct access to the registers of the Intel 7220-1 Bubble Memory Controller (BMC). The commands and operation of the BMC are well documented in the Intel Memory Components Handbook or the BPK-72 Bubble Memory Prototype Kit Users Manual which are available from Intel (Intel Order No. 210830 and 121685 respectively).

The third I/O port address permits reading the J1 switches and the INT and DRQ lines from the BMC and writing to the INT and DMA selects. The DMA select enables/disables the tristate gate between the DRQ of the BMC and the jumper-selected DRQ of the system expansion bus and enables/disables functioning of the DACK signal to the BMC. The INT select enables/disables the tristate gate between the INT from the BMC and the jumper-selected INT of the system bus. The fourth I/O port address is not decoded and functions the same as the third I/O port.

The following table summarizes the functions of the four port addresses for board 1. The port functions for boards 2,3, and 4 are the same except they start at 3C4,3C8, and 3CC respectively.

R/W	PORT(BRD 1)	FUNCTION	
READ	3C0	BMC DATA REG	(A0 = 0)
WRITE	3C0	BMC DATA REG	(A0 = 0)
READ	3C1	BMC STATUS REG	(A0 = 1)
WRITE	3C1	BMC CMD/RAC REG	(A0 = 1)
READ	3C2	J1/INT/DRQ	
WRITE	3C2	DMA/INT SELECT	
READ	3C3	SAME AS 3C2	
WRITE	3C3	SAME AS 3C2	

As indicated, port 3C2 provides access to the settings of the jumpers on group J1. The specific bit assignments of port 3C2 for both reading and writing are shown in the tables below. When there is no jumper at a particular J1 position (NJP), then the bit for that option is set (bit=1)

and vice versa. The BMC DRQ and INT lines and their function and operation are documented in the Intel handbooks referenced above.

PORT 3C2

BIT	READ OPERATION	WRITE OPERATION
B0	BMC DRQ	DMA (ENABLE=1)
1	BMC INT	INT (ENABLE=1)
2	SW1 (UP = 0)	NO CONNECTION (NC)
3	J1-5 FIXED DISK OPTION	NC
4	J1-1 MULTIBOARD OPTION	NC
5	J1-2 BEFORE/AFTER FIXED DISK	NC
6	J1-3 WP/ONLINE SELECT	NC
7	J1-4 RESERVED (DIAGNOSTICS)	NC

BIOS LEVEL OPERATION

The PC Bubble Disk emulates the fixed disk at the BIOS command level. That is, where appropriate, the Bubble Disk BIOS commands are the same in format and function as the fixed disk BIOS commands listed in the IBM PC Technical Reference manual (page A-87).

APPENDIX A

AUTO SCAN BIOS ROM

The PCs with 256K motherboards and all XTs have the newer BIOS ROM with the ROM_SCAN routine. On power-up or reset, this routine scans addresses hex C8000 to hex F4000 looking for ROMs on intelligent adapter cards installed in the system. When a ROM is recognized, an initialization routine at offset hex 3 from the ROM's starting address is called. The Bubble Disk board has an EPROM that is recognized by the SCAN routine, and its initiallization routine installs the necessary software hooks for the Bubble Disk to function as a fixed disk. This is done before the operating system bootstrap is attempted, thus allowing the Bubble Disk to perform this boot when desired. No additional installation software is required for Bubble Disk operation.

However, if you have one of the older PCs without the ROM_SCAN routine on the BIOS ROM, then it is not possible to boot from the Bubble Disk, and a small installation program to be described below must be run after booting from the floppy disk.

DETERMINING IF ROM_SCAN PRESENT

If the FDISK program indicates that no fixed disk is present, this is a good indication that the EPROM on the bubble disk board has not been recognized and its initialization program has not been run as expected if the ROM_SCAN routine were present in the system board BIOS ROM.

If the system is an IBM PC one can determine if the ROM_SCAN routine is present on the BIOS ROM by examining the release date of the BIOS at location hex FFFF:5 using the DEBUG program on the PC-DOS disk. To do this, follow these steps:

```
A>DEBUG <cr>
-D FFFF:5 L8 <cr>
FFFF:0005   31 30 2F-32 37 2F 38 32                10/27/82
-Q <cr>
```

A release date of 10/27/82 or later indicates that the ROM SCAN routine is present on the BIOS ROM.

BUBBLE INSTALLATION WITHOUT ROM SCAN FEATURE FOR PC-DOS

Without the ROM SCAN feature it is not possible to boot directly from the Bubble Disk, and a small program must be run upon bootup. This program is easily created with DEBUG program from the PC-DOS disk as follows (note that the segment address of the bubble board EPROM as set by jumper group J2 should be substituted for Cn00, i.e., Cn00 = C800, CA00, CC00, or CE00) :

```
A>DEBUG <cr>
-N BUBBLE2.COM <cr>
-L <cr>
File not found
-A <cr>
XXXX:0100 MOV AX,Cn00 <cr>
XXXX:0103 MOV DS,AX <cr>
XXXX:0105 CMP WORD PTR [0],AA55 <cr>
XXXX:010B JNZ 120 <cr>
XXXX:010D XOR AX,AX <cr>
XXXX:010F MOV DS,AX <cr>
XXXX:0111 CMP WORD PTR [4E],Cn00 <cr>
XXXX:0117 JZ  120 <cr>
XXXX:0119 CALL FAR Cn00:3 <cr>
XXXX:011E INT 19 <cr>
XXXX:0120 INT 20 <cr>
XXXX:0122 <cr>
-R BX <cr>
BX XXXX
:0 <cr>
-R CX <cr>
CX XXXX
:22 <cr>
-W <cr>
Writing 0022 bytes
-Q <cr>
```

The above operation has created a COM file called BUBBLE2.COM. When run, it first checks to see it the Bubble Disk is present, and, if not, it returns to DOS through INT 20. Next, it checks to see if the bubble disk is already installed which, if true, also forces it to return to DOS. Otherwise, it calls the initiallization routine of the Bubble Disk EPROM and then reboots the system. This procedure causes PC-DOS 2.0 to recognize the Bubble Disk as a fixed disk drive. For convenience the

BUBBLE2.COM may be placed in the AUTOEXEC.BAT file, and since it reboots the system it should be the first program in this file.

BUBBLE INSTALLATION WITHOUT ROM SCAN FEATURE FOR CP/M-86

The following are instructions for patching the CP/M-86 system file to automatically install the Bubble Disk drive upon bootup. This procedure assumes that VERSION 1.1 of CP/M-86 for the IBM PC/XT is being patched.

1) As a precaution, copy the CP/M system disk to another floppy disk and use the copy for the following patch.

2) Boot the CP/M system from the disk and determine if it is a single-sided or two-sided disk by using the command, STAT DSK:. The single-sided disk will show a 156 Kilobyte Drive Capacity and the two-sided disk will indicate a 316 Kilobyte Drive Capacity.

3) Insert the PC DOS disk in drive A and the CP/M disk in drive B. Boot the PC DOS operating system and run the program, DEBUG.

4) If the CP/M disk is a single-sided diskette, enter:

   -L 3B80 1 6C 1

   else if the disk is two-sided enter:

   -L 3B80 1 6E 1

   This command will read a sector (6C or 6E) from drive B into memory at offset E880 from the current CS segment.

5) Enter the following disassemble command and check that the listing is the same as shown. If not try repeating from step 4. If it is still different then the CP/M version is not the same and cannot be patched with this procedure.

```
-U 3BE2 <cr>
XXXX:3BE2 8CC8          MOV     AX,CS
XXXX:3BE4 8ED0          MOV     SS,AX
XXXX:3BE6 BCE23B        MOV     SP,3BE2
XXXX:3BE9 E83101        CALL    3D1D
XXXX:3BEC 8CC8          MOV     AX,CS
XXXX:3BEE 8ED8          MOV     DS,AX
```

```
XXXX:3BF0 8EC0            MOV     ES,AX
XXXX:3BF2 88160642        MOV     [4206],DL
XXXX:3BF6 BE6340          MOV     SI,4063
XXXX:3BF9 E82104          CALL    401D
XXXX:3BFC CD11            INT     11
XXXX:3BFE 054000          ADD     AX,0040
XXXX:3C01 25F3FF          AND     AX,FFF3
-
```

6) Use the following assemble command to change the CALL address at offset 3BE9 above:

```
-A 3BE9
XXXX:3BE9 CALL 4210 <cr>
XXXX:3BEC <cr>
-
```

7) Write the altered sector data back to the disk using:

```
-W 3B00 1 6C 1 <cr>          (for single-sided disk)

-W 3B00 1 6E 1 <cr>          (for two-sided disk)
```

8) Load another sector into memory with the following command:

```
-L 4100 1 6F 1 <cr>          (for single-sided disk)

-L 4100 1 71 1 <cr>          (for two-sided disk)
```

9) Use the following dump command to list the bytes of the loaded sector:

```
-D 4100 L100
```

Half the top half of the dumped area should be zeros and the top half should contain ASCII statements, the last of which is ".FIDDS memory request is too large.....LR:..". If this is not the case, try repeating from step 8. Repeated failure means that this is not the right version of CP/M and this procedure will not work.

10)Using the assemble command shown, enter the following program:

```
-A 4210
XXXX:4210 PUSH AX <cr>
```

```
XXXX:4211 PUSH CX <cr>
XXXX:4212 PUSH DX <cr>
XXXX:4213 PUSH DS <cr>
XXXX:4214 MOV AX,C800 <cr>
XXXX:4217 MOV DS,AX <cr>
XXXX:4219 CMP WORD PTR [0],AA55 <cr>
XXXX:421F JNE 4232 <cr>
XXXX:4221 XOR AX,AX <cr>
XXXX:4223 MOV DS,AX <cr>
XXXX:4225 CMP WORD PTR [4E],C800 <cr>
XXXX:422B JE 4232 <cr>
XXXX:422D CALL FAR C800:3 <cr>
XXXX:4232 POP DS <cr>
XXXX:4233 POP DX <cr>
XXXX:4234 POP CX <cr>
XXXX:4235 POP AX <cr>
XXXX:4236 CALL 3D1D <cr>
XXXX:4239 RET <cr>
XXXX:423A <cr>
-
```

11)Check that the program entered is correct using the disassemble command:

```
-U 4210 L30
```

12)Write the changed sector data back to the disk using:

```
-W 4180 1 6F 1          (for single-sided disk)

-W 4180 1 71 1          (for two-sided disk)
```

13)Mark the CP/M disk as a patched version and boot CP/M from this diskette. If the Bubble Disk is present and the patch was correctly entered, then a hard disk will be present in the "Hardware Supported:" list of the beginning CP/M display. The HDMAINT program should now recognize the Bubble Disk.

APPENDIX B

SPECIFICATIONS

	Bubble Boards Installed			
	one	two	three	four
TOTAL STORAGE (Kbytes):	512	1024	1536	2048
MEMORY ORGANIZATION :				
(Hard Disk Emulation)				
cylinders	15	30	45	60
heads/cylinder 4				
sectors/track 17				

DMA:
  jumper-selectable channel 2 or 3

INTERRUPT:
  jumper-selectable channel 5 or 6

BUBBLE BIOS EPROM ADDRESS:
  jumper-selectable C8000H, CA000H, CC000H, or CE000H

I/O PORT ADDRESS:
  jumper-selectable 3C0H-3C3H, 3C4H-3C7H, 3C8H-3CBH, or 3CCH-3CFH

MEAN ACCESS TIME:
  48 msec

MAX. DATA TRANSFER RATE (BURST):
  50 Kbytes/sec
  (200 Kbytes/sec during last page of READ)

AVE. DATA TRANSFER RATE:
  34 Kbytes/sec

BUBBLE MEMORY OPERATING TEMPERATURE:
  10 to 55°C Case

NON-VOLATILE STORAGE TEMPERATURE:
  -20 to 75°C

SUPPLY VOLTAGE REQUIREMENTS:

Voltage	Margin	Power Off/Fail Decay Rate
+12 volts	+-5%	<1.10 volts/msec
+ 5 volts	+-5%	<0.45 volts/msec

TYPICAL CURRENT REQUIREMENTS:

Voltage	Mode	Bubble Boards Installed One (ma)	Two (ma)	Three (ma)	Four (ma)
+12 Volts					
	Standby	160	320	480	640
	read/write	1000	1160	1320	1480
+5 Volts					
	Standby	490	980	1470	1960
	read/write	500	990	1480	1970

RUN "D:DEMO2"